THE CONJUGAL BEHAVIOR OF THE INTRODUCED EUROPEAN GIANT GARDEN SLUG, *LIMAX MAXIMUS* L., AS OBSERVED ON SOUTH BASS ISLAND, LAKE ERIE[1]

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ABSTRACT

A pair of giant garden slugs, though permaphrodies hermaphrodites, behave as if one were male and one were female during the period just preceding, during, and after mating. A description of this behavior, with photographs, is presented, and the possibility of protandrism is suggested.

The Giant Garden Slug is abundant in the vicinity of dwellings, outbuildings, and other structures on South Bass Island, Ohio, but, although it climbs trees (fig. 1), it has not been found in woodlots on the island. Its presence may be attributed to the importation of nursery stock by early settlers of German origin, and these slugs might have come to the island in this way directly from Europe. It was first found in the United States near Philadelphia in 1867, and it spread westward, with a record from Los Angeles in 1890 (Pilsbry, 1948).

Slugs mate at night, so their mating behavior has not been observed often. My attention was directed to the opportunity to see this interesting performance

FIGURE 1

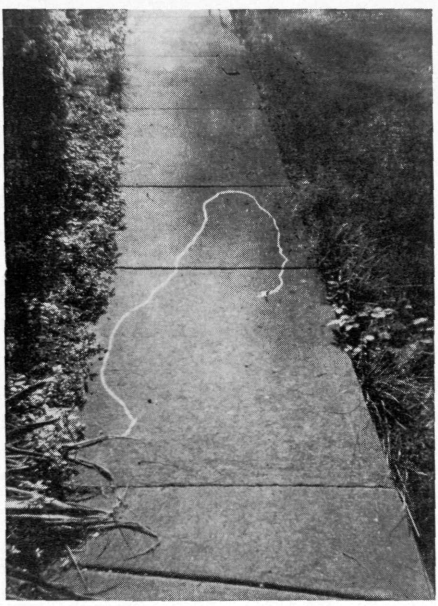

FIGURE 2

FIGURE 1. Unmated slugs assembled on an oak stump at night.
FIGURE 2. Slug slime track the morning after it was made.

by Dr. Anthony Bodola, and some of my photographs were taken at his house, between August 21 and September 4, 1955. The mating habits of the Giant Garden Slug were observed by Adams (1898), and later described also by Pilsbry

[1]Manuscript received October 12, 1963.

FIGURE 3

FIGURE 4

FIGURE 5

FIGURE 6

FIGURE 3. Approach rejected—contact broken.
FIGURE 4. Approach accepted—contact permitted.
FIGURE 5. Contact maintained while climbing a wall.
FIGURE 6. End of the climb, the *fbi* starts around.

(1948, 2(2): 524–527), with reference to a classification of slugs based upon specific breeding behavior by Gerhardt (1937). There is also a brief description of this behavior by Karlin and Bacon (1961: 404). None of these records portray some phases of the behavior which is here recorded, with words and photographs.

Trails of glistening slug-slime may be seen early in the day (fig. 2), showing where slugs emerged from their hiding places, under stones or other objects, trav-

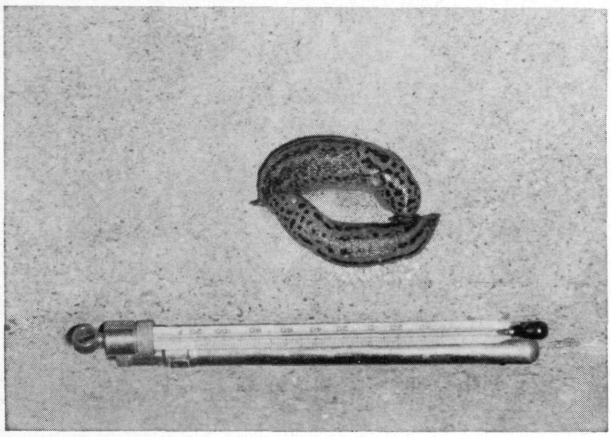

FIGURE 7. Slug "O," each mouthing mucus near the tail of the other.

elled to objects of food, then sought similar niches for another night. They are most active between 10 PM and dawn.

While these slugs, being hermaphrodites, undoubtedly exchange sperm when mating, a pair behaves as if one were a male and the other a female, starting when one slug encounters another slug on the ground or on a tree. The male-behaving-

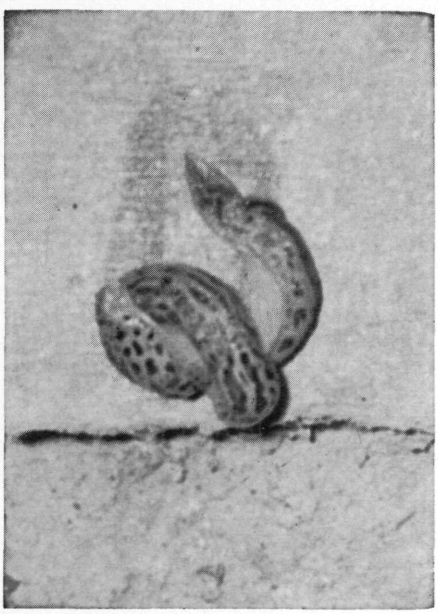

FIGURE 8. Slugs uplifting and crossing bodies exposing slime "O" on wall.

individual (*mbi*) starts trailing the other slug, and the second slug, if also an *mbi*, shakes its tail vigorously to break contact (fig. 3), after which they go their separate ways. If, however, the second slug is a female-behaving-individual (*fbi*), it leads the way, with the trailor mouthing its tail (fig. 4), to and up a tree or wall (fig. 5). When the slugs reach an area with overhang, the *fbi* stops climbing, curves around (fig. 6) and starts mouthing the tail tip of the trailor, thus making an O of the two bodies (fig. 7).

The slugs remain in this position for some time, perhaps an hour, and both slugs actively secrete mucus onto the surface of attachment. Suddenly, the *fbi* raises its front end, thus breaking attachment to the slime-coated surface of the

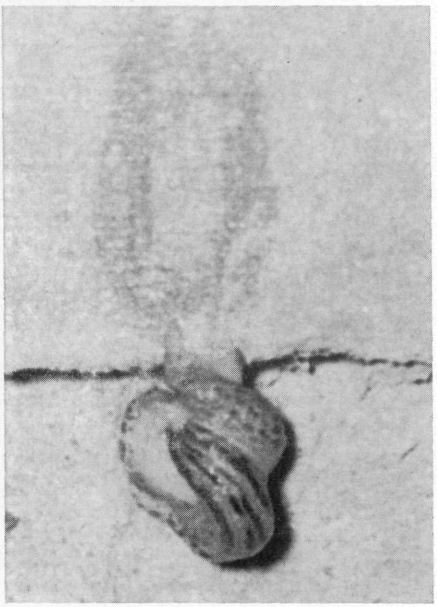

FIGURE 9

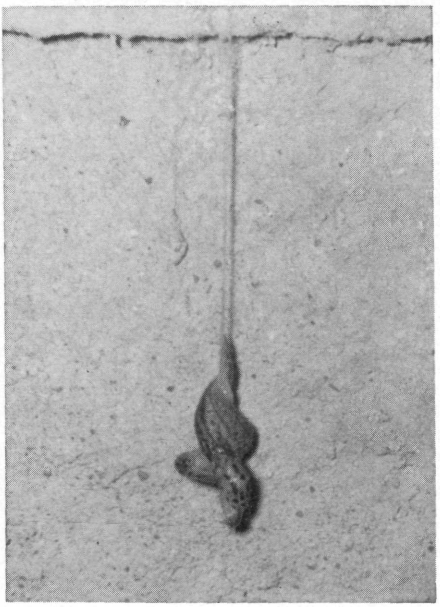

FIGURE 10

FIGURE 9. Slime string attached to the "O" as slugs begin suspension.
FIGURE 10. Pair hanging, separating anterior ends.

tree or wall except at its tail's tip, and it crosses the body of the *mbi*. The *mbi* promptly seconds this motion, twisting actively around the body of the *fbi* (fig. 8). As each slug crawls onto the body of the other slug they crawl off of the wall and do a slow-motion head-dive together, suspended by the tips of their tails on a doubled slime string, from their slimy O on the surface which they had left (fig. 9). They pause when they have dropped from 6 to 12 inches below the point of attachment, and they dangle, head down and rotating on the end of their string.

Thus hanging and rotating, the slugs separate their head ends (fig. 10), and each then everts a verge (penis) through the genital pore on the right side of its head end. Each verge is a whitish cylinder, perhaps 1½ inch long by ⅛ inch in diameter. This tube flattens out, and has a frilled edge, and its color becomes a translucent blue. The verges twist and probe until they contact each other, then they intertwine, (fig. 11) and the common structure tightens its coils and flares out midlength, like an umbrella. Each verge, at its body-end, is a tube through which seminal fluid can be seen passing, in pulses, toward the umbrella. Presumably, the sperms of each slug are then being transferred onto the spread surface of the everted verge of the other. Presently, the verges separate, and are

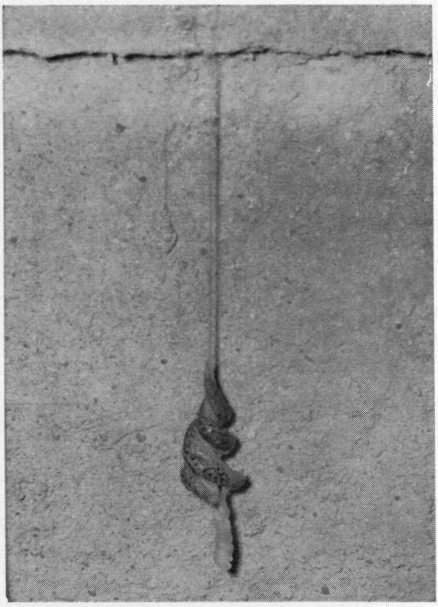

FIGURE 11

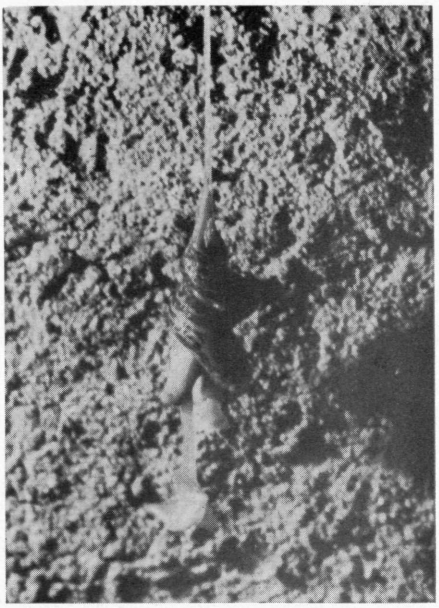

FIGURE 12

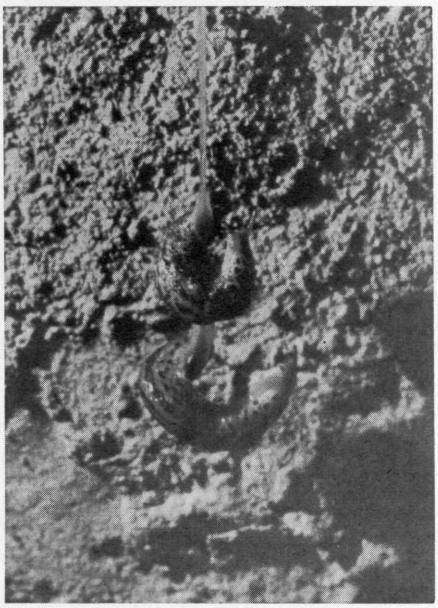

FIGURE 13

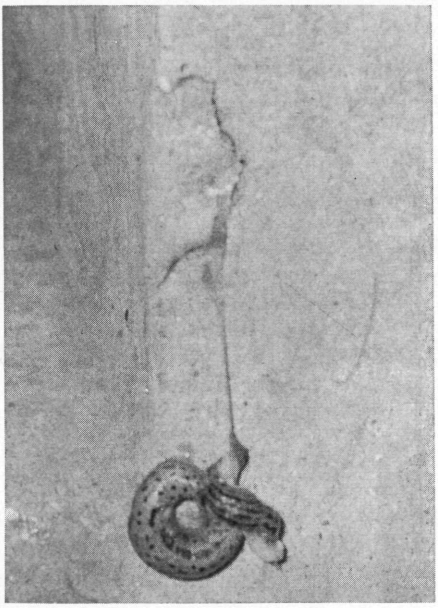

FIGURE 14

FIGURE 11. Verges intertwining.
FIGURE 12. Verges separated and one nearly retracted.
FIGURE 13. Bodies untwining.
FIGURE 14. One slug has crawled off the string onto the wall.

withdrawn into the slug bodies (fig. 12), and the sperm smears are then on the insides of the organs.

Once again, as they untwine (fig. 13), the difference in the behavior of the mating slugs manifests itself. One, presumably the *fbi*, reaches out to make contact with the nearby vertical surface, moves off of the mucus string (fig. 14), and presently moves on down to the ground. The other slug, presumably the *mbi*, climbs up the mucus string (eating it, according to Adams (1898: 93) but not when observed in this study) and beyond its terminal O onto the tree, or wall (fig. 15). Here it stops, turns its anterior end sharply and licks the side of its body posterior to its genital aperture. Presently, it descends along the mucus string, in this study eating it as it goes, (fig. 16) which explains the fact that mucus

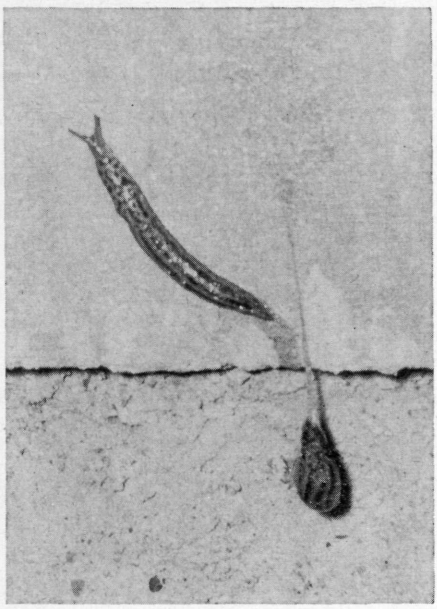

FIGURE 15

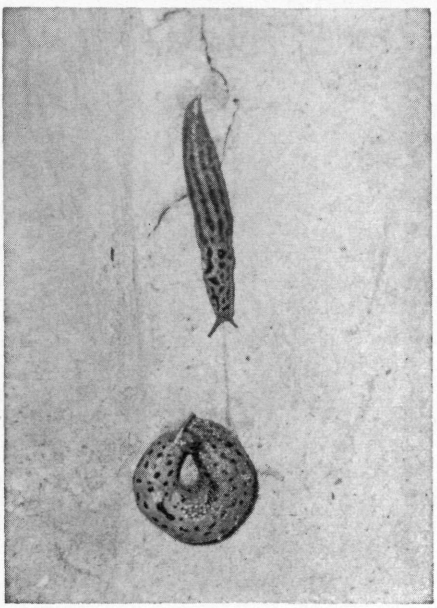

FIGURE 16

FIGURE 15. One climbing up the wall.
FIGURE 16. Slug eating slime string on its way down.

strings are seldom seen after they have served the purpose for which they were made.

Adams (1945) found a series of albino garden slugs and was enabled thereby to refer to the slugs there as a "colony." By the invention of a system of marking slugs so they could be identified as individuals, and the observations of mating of slugs made within a restricted area for entire seasons, much information could be gained. Slug hermaphroditism might prove to be protandric, as Orton (1909) described for another mollusk, in which the same individual is at one time male and at another time female.

Cooke divided those hermaphrodite mollusks into two groups, one having separate orifices for male and female organs, the other having one orifice for both, and slugs are in the latter category. Cooke stated further (133–134) that in the latter case, during union, mutual impregnation takes place and each of the individuals pairing deposits eggs.

Few additional observations on the life history of the Giant Garden Slug were made. A clutch of slug eggs, not counted but about thirty in number, was found

FIGURE 17. Slug eggs exposed by removing a log.

when I rolled a log out of position, September 17, 1956. I covered the area with a slab of bark, and ringed the eggs with a piece of string. Next day the eggs had been moved en masse, and were found on top of the string (fig. 17), an observation without much value, since I had no clue as to how the eggs may have been moved.

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